SECTION 1

EXECUTIVE SUMMARY

This Interim Report is presented to summarize data collected as part of a multi-year cooperative research and development agreement (CRADA) between the U.S. Environmental Protection Agency (EPA) and Waste Management, Inc. (WMI), examining two techniques of landfill bioreactor construction and operation. The project is underway at the Outer Loop Landfill located in Louisville, Kentucky, operated by WMI. Data presented here follow a quality assurance project plan (QAPP) established by the researchers prior to commencement of the project. The QAPP, appended herein, contains testing parameters, prescribed monitoring frequencies, and required quality control procedures.

The purpose of the research effort is to assess which monitoring parameters provide superior indicators or measurements at a municipal waste landfill operated as a bioreactor, and to the extent possible, determine if this operational technique represents an improvement over conventional landfill management. The QAPP contains a prioritized list of monitoring parameters assembled by researchers, based on previous bioreactor research and understanding of landfill operation. This landfill research is designed to operate within the existing regulatory requirements, and the experiment has the regulatory approval of The Commonwealth of Kentucky.

The experiment contains three key components as described in Table 3-1:

- a conventional RCRA Subtitle D landfill which serves as the experimental Control (Area 7.3);
- a bioreactor operational technique applied to an existing landfill cell, termed "facultative landfill bioreactor," (FLB), also called "retrofit" (Area 5); and,
- a new bioreactor landfill cell called the aerobic/anaerobic landfill bioreactor (AALB), also called "as-built"(Area 7.4).

Each treatment and control (the control is considered a treatment for statistical purposes) is replicated with subcells to enhance comparisons and statistical understanding of data and trends.

As is common with full-scale research, there are several challenges associated with testing the behavior of operating landfills. In addition to the variability of waste composition for each vehicle load of refuse discharged at the site, other variable are present as part of this research investigation. For example, waste age, density, moisture content, and waste volume within each cell differ by treatments. Waste was first disposed in the FLB, three and half years later in the Control, and another year later in the AALB (see Section 3). Other confounding factors exist, including dissimilar cell geometries, and the inability to split incoming waste loads into the replicate cells. These differences in time sequence will need to be taken into account so as to interpret the superior performance of certain monitoring parameters.

As the project progresses, it is envisioned that the treatments and resulting data can be aligned according to time, geometry and amount of waste. Moreover, municipal solid waste is a highly heterogeneous material, and the purpose of this research is to observe the response and range of parameter trends that occur within landfill bioreactors when compared with 'normal', conventional landfill treatment. This research provides an opportunity to study and compare the performance of new landfill designs in the manner of controlled experiment. The results are expected to be variable but in kind with the variances typically seen with landfill research.

INTERIM FINDINGS

Based on results compiled through April 2003, there are already important and striking results at this stage of research. These are summarized below.

Landfill Operations

The bioreactor landfills have operated within RCRA Subtitle D and Clean Air Act requirements of a state-of-the-art municipal waste landfill. Leachate **head on liner** levels between control (conventional) and bioreactor treatment cells remain similar. Determination of leachate injection rate has been reasonably event free with minor operational issues addressed early on. There have been no slope stability issues associated with bioreactor or control treatments. The landfill gas extraction system has successfully used horizontal collection piping. Fugitive surface emissions were routine and corrected within the regulatory time requirements and have remained below methane concentration requirements. **Waste and leachate temperatures** are elevated as expected, indicating waste degradation. The AALB shows the highest mean temperatures at 28^{o}C and 27^{o}C, compared to the FLB at 20.0^{o}C and 28.2^{o}C, respectively. The Control cell had waste and leachate temperatures of 16.6^{o}C and 16.6^{o}C, respectively.

Trends in Physical, Chemical and Biological Parameters

Waste Settlement in the AALB is greater than in the other two treatments. This is probably due to the addition of leachate and resulting consolidation from seepage force. However, it is not statistically conclusive at this point in time (see Appendix D). There is more surface settlement in the FLB in the south east corner. This is consistent with the fact that this is where the new waste was added after sampling baseline solids sampling in June 2000 (See Figures 3-1, 3-2, and 5-6.)

Air space utilization values (AUF) have increased significantly for both treatments when compared to the Control cells, with the AALB approaching a calculated in-place waste density of 1,900 lbs/yd ^{3}. This may be partially explained by enhanced physical settlement due to moisture addition but it also represents the effect of biological decay based on the MSW solids data discussed below. (See Figure 5-8).

MSW Solids Data indicate that the changes in degradable organics are occurring in each of the treatment and control cells. In general, the AALB cells have shown the highest rate of change followed by the Control and then FLB cells. These data are shown with **BMP, cellulose, cellulose+hemicellulose/ lignin ratio.** This result was expected as the AALB treatment cell is

the most highly engineered and represents the most aggressive treatment of the experiment. (See Figures 5-40 through 5-44).

In the trend summary, (Appendix D), the **Leachate Ammonia and TKN** values tend to trend downward for FLB cells as was expected with this treatment. This was not seen in the control or AALB cells. (See Figures 5-23 and 5-28).

Fugitive Gas Emissions measurements were conducted for the FLB, AALB, and Control cells. Measurements were conducted using optical remote sensing. Radial and vertical scanning measurements using open-path Fourier Transform Infrared Spectroscopy (OP-FTIR) were conducted above surface and downwind from the sites.

The AALB was found to have 160 g/s of methane, considered a conservative estimate because complete capture of the gas plume was not possible. Additional sampling is being conducted. This report provides data for sampling conducted in September 2002. A description of the measurements and analysis of the results are presented in Appendix E.

The Final Report with help clarify more of these issues with a larger data set over a longer period of time. It is anticipated that this will be achieved at the end of this research effort. Our intent is to study other landfill sites to evaluate bioreactors under different conditions in the United States.